SAULT COLLEGE
of Applied Arts and Technology
Sault Ste. Marie

COURSE OUTLINE

STRENGTH OF MATERIALS

MCH 103-3

revised June 1981 by W.J. Adolph

STRENGHT OF MATERIALS MCH 103-3

Topic	Periods	Topic Description	Reference
#1	4	Laws of Equlibrium, Internal Forces and Reactions method of sections - structures analysis of frames	
#2	6	Concept of Stress general definition of stress formula and specific definition for: 1. Normal stress (axial, tensile and compressive) 2. Bearing stress. 3. Shear stress. -stresses on oblique planes. -vector addition-components and resultants -stress concentration and factors -working stress; and safety factor.	L-1
#3	4	Thin Walled Cylinders review of pressure concept longitudinal stress circumferential stress stress in pressurized spheres	L-16
#4		Concept of Strain strain and deformation the stress---strain curve Hookes law Youngs modulus the Equations of elasticity Poisson's Ratio the modulus of rigidity	L-37
#5		Thermal Strain co-efficient of thermal expansion thermal; load deformations	L-51

Topic	Periods	Topic Description	Reference
#6		Welded Connections types of weldments design of butt welds design of fillet welds (a) gusset plate weldment (b) angle section weldment	L-P237
#7		Bolted Joints single multiple connectors design for: (a) shear failure (b) bearing failure (c) tensile failure	L-241
#8		Moment of Inertia moment of inertia for rectanular shapes about its own neutral axis. moment of inertia for rectanular shapes about any transverse axis. moment of inertia for composite rectangular shapes.. section modulus radius of gyration	
#9		Shear and Bending in Statically Determinant Beams Reactions vertical shear force diagrams bending moment diagrams point of maximum bending maximum bending moment flexure formula	

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General Objectives

The general objectives are as follows:

The course provides a review of some concepts such as method of sections and free body diagrams for the determination of internal forces and reactions.
A base for subsequent strength courses is built rising concepts of stress, strain, moment of inertia.
Vertical shear and bending moment diagrams.
Work habits encouraged and developed in the first semester are reinforced with a generous number of assinged problems.

Specific Objectives

Topic #1 --- Laws of Equilibrium, Internal Forces and Reactions.

This review work is drawn from such sources as "Introduction to Mechanics", 2nd. edition, book 2, Levinson.

The student will be able to:

1. State the mathematical conditions for equilibrium.
2. Isolate members and portions of members, using free body diagrams.
3. Determine reactions, horizontal and vertical, using the laws of equilibrium and free body diagrams.
4. Determine forces in truss members by the "Method of Sections".
5. Determine pin reactions in frames.
6. Resolve forces in frame members into axial and transverse loads.

Topic #2 --- Concept of Stress

The student will be able to:

1. Define stress in qualitative terms.

2. Explain "stress" by using an analogy to pressure.

3. State the formula for uniformly distributed axial stress, using the correct symbols.

4. State the formula for uniformly distributed shear stress, using the correct symbols.

5. State the units of stress, load and area and prove the units of each variable by dimensional analysis.

6. State the formula for bearing stress.

7. Explain the meaning of "double stress" as it applies to the shearing action of a doubly supported pin.

Stress of Oblique Planes

8. Draw a free body diagram and relate the internal reaction at a section to the externally applied forces.

9. Resolve the internal reaction on planes other than transverse planes into components normal to, and parallel to the plane.

10. Determine the normal stress and shear stress existing in the member regardless of the inclination of the oblique plane.

11. State the angles relative to the transverse plane at which normal stress and shear stress are maximum.

Working Stress and Factor of Safety

12. Define "factor of Safety" in terms of "stress necessary to produce failure" and working stress.

13. Explain the meanings of "working stress", and/or allowable.

14. Complete corectly, the assigned problems involving the concept of stress.

Topic # 3 Thin Walled Cylinders

The studentwill be able to:

1. Define pressure in terms of force and unit area.

2. State the formula relating pressure, force and area .

3. State the formulae relating internal pressure, wall thickness, nominal vessel diameter and induced stress, both circumferential and longitudinal.

4. Correctly complete the assigned problems of Topic #3.

Topic #4 Concept of Strain

The student will be able to:

1. Define the terms "strain and deformation" in a qualitative manner.

2. Recall the qualitative meaning of "stress".

3. Given a stress - strain curve for a typical ferrous metal or ferrous allay, identify significant points and features.

4. Distinguish between a true S-S curve and an apparent S-S curve.

5. State Hooke's Law.

6. Define in qualitative terms, Young's Modus, or the modulus of elasticity.

7. From the definition of Young's Modulus and from recalling the definitions of stress and strain, develop the equation for deformation.

8. Manipulate the formula for deformation, solving for any unknown quantity.

9. Explain qualitatively, the behavior of two materials in series, deforming under axial load.

10. Explain qualitatively the behavior of two materials in parallel deforming under axial load.

11. Define poissons ratio in terms of laterial strain and axial strain.

12. Define the modulus of rigidity in terms of Poisson's ratio and the modulus of elasticity.

13. Correctly complete the assigned problems of Topic #4.

Topic #5 Thermal Strain

The student will be able to:

1. Define the co-effeciental thermal expansion in terms of "strain" and change in temperature.

2. State the formula for thermal deformation in terms of the coefficient of thermal expansion, the length of the member and the change in temperature.

3. Relate deformation due to load to deformation due to heat.

4. Explain qualitatively the behavior of various mechanical systems under the influence of both load and temperature change.

5. Correctly complete the assigned problems of Topic #5.

Topic #6 Welded Connections

The student will be able to:

1. Differentiate between butt and fillet welds.

2. State the formula for determining the load carrying capability of a butt weld, being aware of the special definition of "T".

3. State the formula for the load carrying capability of fillet welds.

4. Sketch the configunation and "call for" various structural shapes.

5. Using simple structural design tables, select specific dimensions and shapes propeities.

6. Define efficiency of a welded joint.

7. Correctly complete the assigned problems of Topic #6.

Topic #7 Bolted Connections

The students will be able to:

1. State the three modes of failure anticipated and designed for a bolted connection.

2. State the formula for load carrying capability of the joint based upon permissible shear stress of the bolt material and the area in shear.

3. State the formula for load carrying capability of a joint depending on the strength in bearing of the material being jointed.

4. State the formula for load carrying capability of the net area in tension in the load carrying member.

5. Explain how to calculate the load carrying capacity of a single connector joint considering the three possible failure modes.

Multiple Connectors.

6. In a joint in which there are two or more lines of bolts, be able to explain:
   (a) How the bolts share load
   (b) How load is shared by the projected areas of the drilled holes in the load carrying member.
   (c) How the load is considered to be carried across the lines of bolt holes through tensile load capability of the net area of the load carrying member.

7. Correctly complete the assigned problems of Topic #7.

Topic #8 Moment of Inertia

The student will be able to:

1. State the formula for the moment of inertia of a rectangular shape about its centroidal X-X and Y-Y axis.

2. State the formula which permits the calculation of the moment of inertia of a rectanular shape about any axis. (transfer formula)

3. Locate the correct value for the moment of inertia from structural tables.

4. Explain how the moment of inertia of a composite.

5. State the formula relating section modulus, moment of inertia, and the distance from the neutral axis of a beam.

6. Explain the meaning of neutral axis.

7. State the formula relating radius of gyration moment of inertia and area.

8. Correctly complete the assigned problems of Topic #8.

Topic #9

The student will be able to:

1. Illustrate by sketches the difference between point loads uniformly distributed loads, and non uniformly distributed loads.

2. Explain the method for calculating and checking the reactions for simply supported and cant lever members under the influence of various loadings.

3. Recall the meanings of vertical shear force and bending moment.

4. By the use of free body diagrams of sections of a beam, explain how vertical shear forces and bending moments can be calculated.

5. Draw according to convention, the vertical shear force diagram for a loaded - supported beam.

6. Draw according to convention, the bending moment diagram for a loaded - supported beam.

7. Correctly complete the assigned problems of Topic #9.

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Suggested Text

Mechanics of Materials, 2nd. edition
Irving J. Levinson
Prentice Hall

Other Texts for Reference

Strength of Materials, 2nd. edition
John N. Cernica
Holt, Rinehart and Winston

Resistance of Materials, 4th. edition
Sealy and Smith
Wiley (Adolph's copy)

Applied Strength of Materials
Jensen

Mechanics of Materials
Popov

Introduction to Mechanics
Irving J. Levinson
Prentice-Hall